Common Scab: A Review

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ICE
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- I have worked with potatoes since 1971 (that's 42 years for those mathematically challenged) and mostly I have tried to avoid scab, because it seemed there were only four things you could do about scab, and none of them worked
  - Avoid high pH soils; you have to farm what your grandparents homesteaded
  - Don't put livestock manure on your soils; what to you do with it?
  - Keep soil moisture high and even; without irrigation, going to church is the only option
  - Use resistant varieties; do you know any?

- During my career, I have been asked more questions about scab control than any other disease, regardless of where I am in the world
- Now I have to think about scab since Andy asked me to do this overview
- My job is to provide an overview of common scab that will give you some education about this disease – probably more than you want to know

The disease

- The disease occurs wherever potatoes are grown; Americas, Europe, Africa, Asia
- First unmistakably identified in US in the early 1890's (Hooker)
- Affects tubers, lower stem, roots, stolons
- Main damage due to the formation of lesions on the surface of tubers that detract from appearance and can lead to market rejection
  - Affects grade and quality, rarely yield
- Huge range of symptoms


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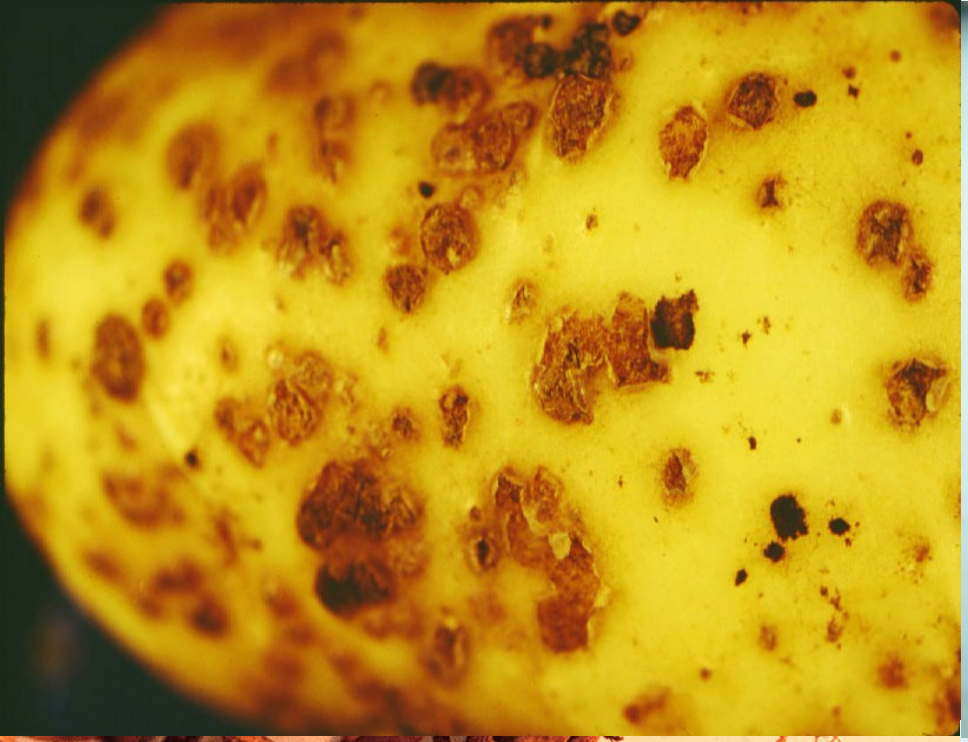
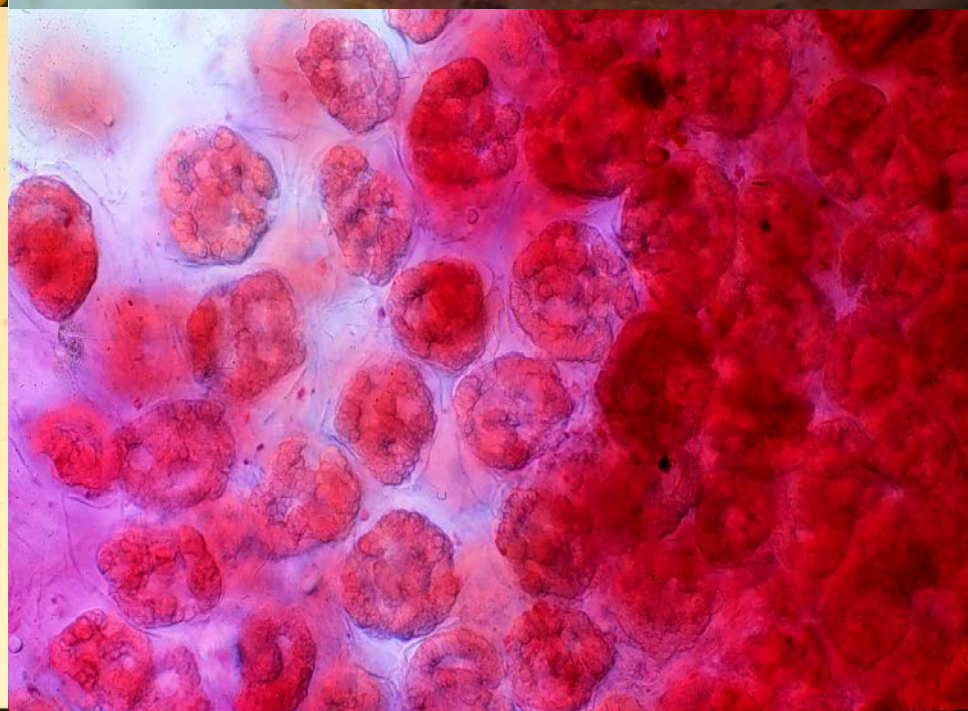
- Symptoms may resemble those of powdery scab, and laboratory examination is required to determine the cause; confusing even to experts
- Microscopic structures or PCR

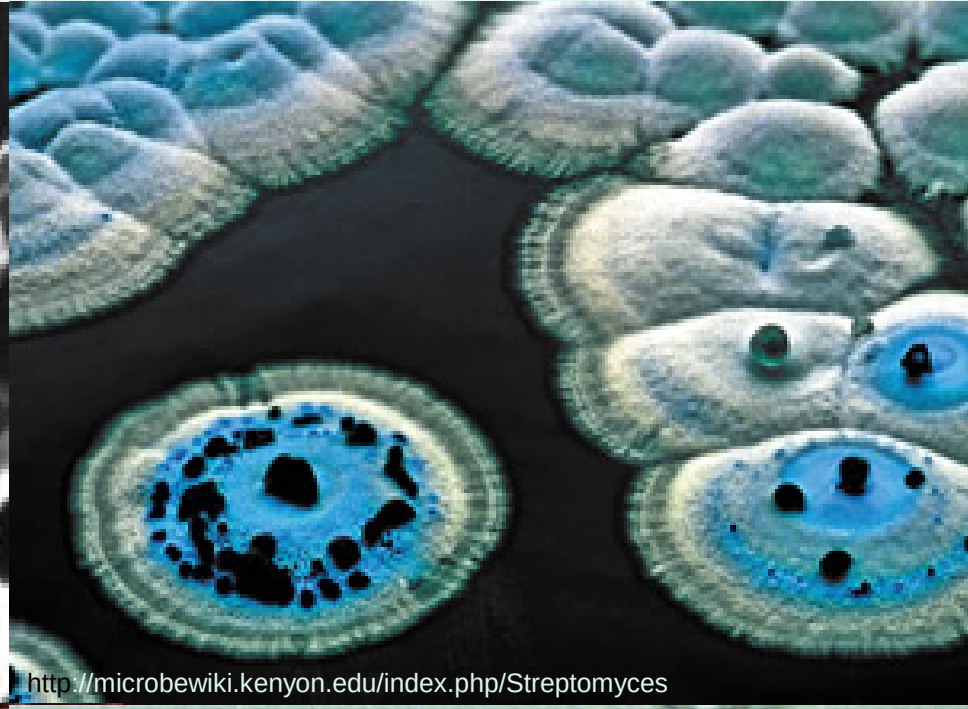




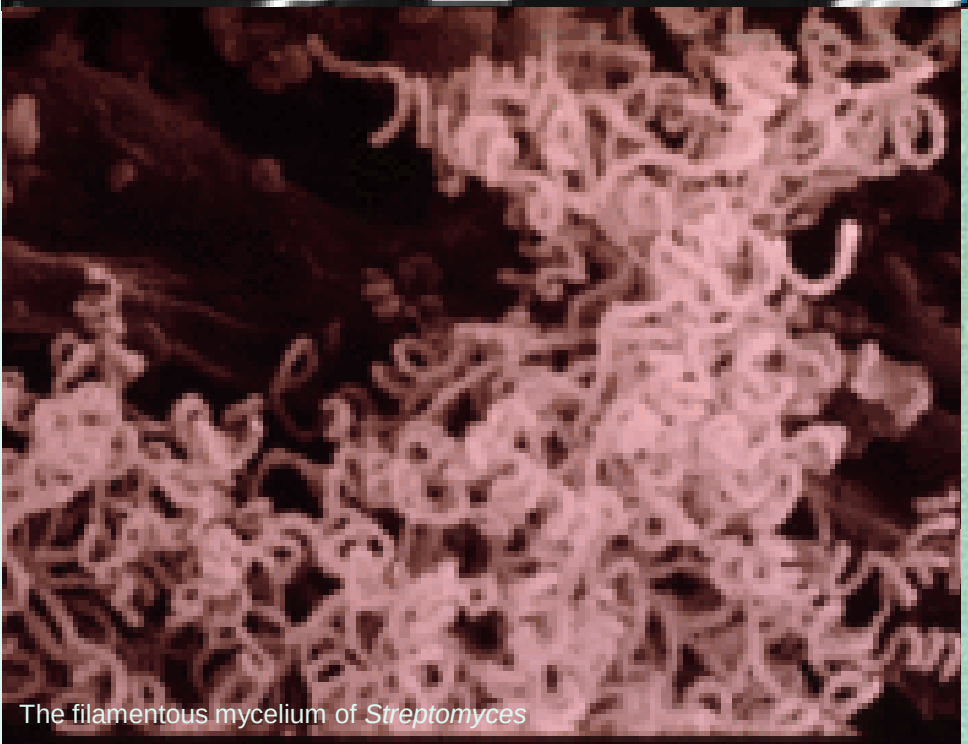
- Scab affects other soil crops including beets, carrots, parsnips, radishes, rutabagas, turnips, sugar beets (Hooker) sweet potatoes (Wanner) and peanut pods (Lambert and Loria)

- Common scab is a disease incited by an actinomycete named **Streptomyces**
  - An unusual group of Gram positive filamentous bacteria
  - Produce branched filamentous mycelia
  - Spiral sporophores
  - At maturity produce spores
  - Produce secondary metabolites
    - Antibiotics (streptomycin), anti-tumor agents, immunosuppressants (Loria et al)
    - Phytotoxins

Streptomyces plicatos by: K. Furihata & T. Shomura.



http://microbewiki.kenyon.edu/index.php/Streptomyces



The filamentous mycelium of *Streptomyces*

http://www.apsnet.org/Education/IllustratedGlossary/PhotosA-D/actinomycete.htm

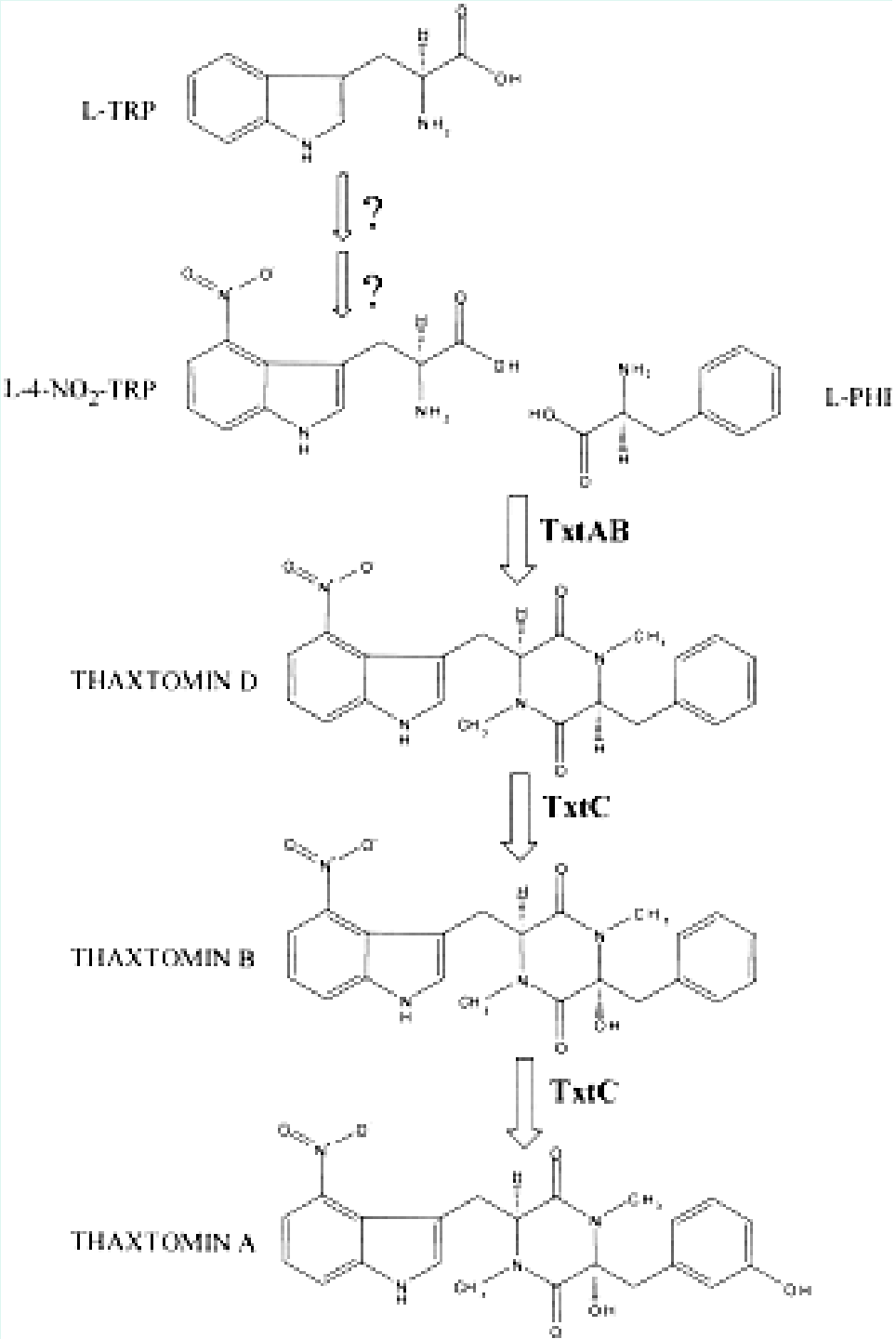
- The traditional cause of common scab is *Streptomyces scabies*
- First described in 1891 (Loria et al.)
- Most Streptomyces are saprophytes that do not cause disease; those that cause disease arise periodically
- Within last few years other species of Streptomyces causing potato scab have been described (Wanner)

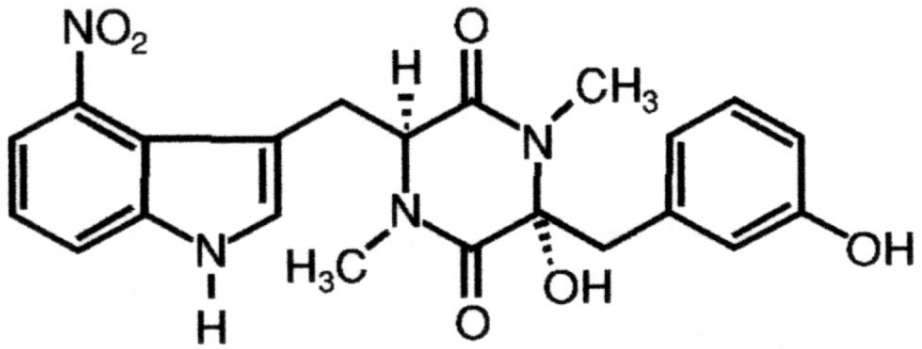
- S. acidiscabies (Lambert and Loria, 1989); grows in acidic soils in the maritime US and Canada (Manzer et al, 1977)
- S. europascabiei
- S. stellascabies — Star crack scab
- S. bottropensis — Egypt
- S. turgidiscabies — Pitted scab
- S. aureofaciens — Netted scab
- S. reticuloscabiei — Netted scab
- Three species from Korea

- The pathogen is
  - Tuber-borne
  - A soil inhabitant, not a visitor
- Infection occurs through lenticels, stomata, wounds and insect feeding injury
- Over winters in soil and tubers
- Persists many years; indefinitely

Pathogenicity Factors

- Thaxtomin; main toxin responsible for pathogenicity and symptoms
  - Nitrated dipeptides A and B
  - Tyrosine:tryptophan (thaxtomin A)
  - Phenylalanine:tryptophan (thaxtomin B)
- Enzymes
- Virulence factor; nec1 protein


L-TRP
?
?
L-4-NO2-TRP
L-PHE
TxtAB
THAXTOMIN D
TxtC
THAXTOMIN B
TxtC
THAXTOMIN A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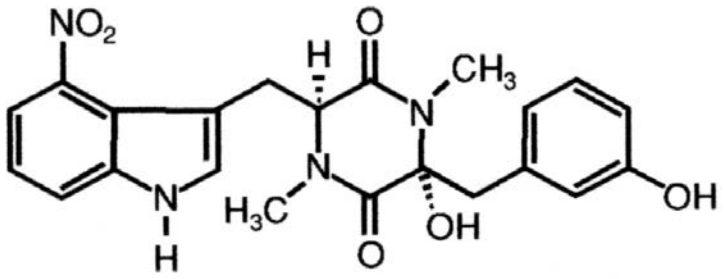
Thaxtomin A

Thaxtomin A



Thaxtomin A

- Inhibits cellulose biosynthesis enzymes;
  - Prevents normal cell wall synthesis; results in cell death;
  - All plant cells have cell walls
- Thaxtomin plus the other virulence factors form “pathogenicity islands”
- These islands can move among Streptomyces species creating new scab pathogens by converting non-pathogenic Streptomyces to pathogens
- May explain variability in symptoms

Control

- Now we understand the pathogen and how it causes disease better, what does this mean for control?
- This is the area that needs some creative work

- **Control Strategies**
  - Clean Seed
  - Chemical Protection
  - Resistant cultivars
  - Cultural Practices
    - Maintaining soil moisture
    - Soil pH
    - Crop rotation

Scab free seed

- Prevents introduction into virgin fields
- Scab free seed is preferred
- Difficult to find totally scab free seed
- How much is too much?
  - What is the threshold?
- Certification not based on scab, not a cause for rejection, but type and coverage are noted

Chemical

- Fungicides
  - Mancozeb, coppers, streptomycin, PCNB seed treatment or in furrow application purported to reduce scab
  - Generally not effective; not consistent
  - May reduce seed-borne inoculum, but no effect on soil-borne inoculum, which is probably the main source

- Insecticides
  - Mocap (etheprop) purported to reduce scab by controlling soil insects (springtails, flea beetle larvae) feeding on tubers that make injuries that can act as entry sites; importance not known
- Soil amendments
  - Many sold to control scab, but most do not work
  - Growers beware; example

- A product is recommended at 1 gal in 250 gal of water to cover 10 acres and guarantees “a reduction in the incidence of scab if the above instructions are met”
  - If you do the math, that turns out to be 2 ml/sq ft or 40 drops /sq ft
  - Do you think that will work?

Chemical (Cont.)

- Soil fumigation
  - Vapam (sodium isothiocyanate) may actually make scab worse by killing suppressive soil micro-organisms
  - Continuing work with chloropicrin (tear gas) shows good control of pitted scab (ON, WI, MI, FL)
    - >45°F and 30-day interval post-application planting restrictions would require fall application in most seasons.

Resistance

- Many cultivars with resistance have been released
- Resistance may vary between locations:
  - example: scab resistant in ND, when planted in NE, is susceptible
  - different scab species or biotype?
- Best and most effective control if it can be identified
  - Major effort by most breeding programs
  - Durability of resistance??

Soil moisture

- Best cultural practice to reduce scab
- Known since 1923 (GB Sanford, University of Alberta)
- Even and high soil moisture beginning at tuber initiation and continuing 4-6 weeks
  - Need irrigation

Rotation

May help, but S. scabies is a soil inhabitant and persists in soil basically forever

Soil pH adjustment

Adjusting soil pH with lime or sulfur difficult/expensive; not a good option

Unanswered questions and challenges

- How important is seed-borne inoculum?
  - Is there a threshold of coverage that contributes to disease of progeny tubers?
- The need for a seed treatment that controls seed-borne inoculum.
- An understanding of soil antagonists and suppressive soils. A huge soil microbiology area.
  - Example: Disappearance of scab from scab nurseries in ND
- Development of soil fumigation: biological (glucosinolates) or chemical (chloropicrin).
- Durability of host resistance.
- New control methods that work consistently.